4. FIELD ACTIVITIES

The following sections describe the field activities and procedures to be used to meet the DQOs described in Section 3.1. Prior to commencing any sampling activities, a pre-job briefing will be held with all work-site personnel to review the requirements of the FSP, HASP, and other work control documentation, and to verify that all supporting documentation has been completed. Additionally, at the termination of the drilling and instrument installation activities, a post-job review will be conducted. Both pre- and post-job briefings will be conducted in accordance with Management Control Procedure (MCP)-3003, "Performing Pre-Job Briefings and Post-Job Reviews" (INEEL 1998a).

The OU 3-13 Group 4 perched water well installation program will include the lithologic and geophysical logging of boreholes, and the collection of alluvial, shallow, and deep sedimentary interbed materials for both Phases I and II. In addition, tensiometer, lysimeters, moisture sensors, piezometers, and aquifer monitoring wells will be installed to monitor vadose zone soil moisture, water chemistry, and perched zone and aquifer heads. The sampling requirements addressed in this FSP include collection of borehole data, sampling of interbed sediments, groundwater sampling from the Phase I instruments, (including the tracer test sampling), and the initial round of Phase II sampling. The long-term collection of tensiometer and moisture sensor readings, and sampling of pore water and groundwater is not part of this FSP, but is covered under the Long Term Monitoring Plan for Group 4 (DOE/ID-10746).

4.1 Well Locations

This well installation program will be accomplished in two phases. The justification for each phase is provided below.

4.1.1 Phase I Wells

The Phase I wells will allow better determination of the perched water recharge sources and will support the tracer tests. The goal of each tracer test (and the well location selection) is to provide information about the hydraulic connection between the recharge sources and the upper and lower perched water zones.

The wells will be in sets of 2 to 4 wells each. This strategy allows sampling of perched water in the same location at the multiple depths of concern: alluvium/basalt interface 9.0 to 13.7 m (30 to 45 ft), upper perched water (36.6 to 42.7 m [120 to 140 ft]), and lower perched water (115.8 to 128 m [380 to 420 ft]). The deepest well in each set will be drilled first. After the deep well is drilled, it will be geophysically logged. The borehole geophysical logs provide information on stratigraphy and locations of perched water; they will also be used to determine completions for each well in the set. The boreholes will be completed with instrumentation including tensiometers, suction lysimeters, and a piezometer wherever possible. This approach provides the best monitoring possible for the tracer test.

The criteria for placement of the wells is based on professional knowledge of the INTEC facility gained through past investigations, a thorough review of the stratigraphy of surrounding wells, past water sampling event results, and water level elevation monitoring. The criteria for selection of the Phase I and II well locations are similar, because the Phase I wells will be placed not only to monitor the tracer test but also to monitor the drain-out of the perched water (Phase I wells will become part of the Phase II monitoring network). The criteria for selection of Phase I well locations include:

- Near known significant recharge sources

- Near areas that will help examine the boundaries and connection of perched water zones

- Near areas where perched water in the alluvium may develop

4.1.1.1 Big Lost River Well Set. This well set will be located south of the Big Lost River (BLR) (see Figure 4-1). The alluvial well will provide a location for sampling any perched water that may develop in the alluvium as a result of flow in the BLR. The upper and lower perched water wells will provide locations for sampling the perched water zones in the northern INTEC area. The set will be placed in a location near the BLR where monitoring wells currently do not exist. These wells will serve as the monitoring points for the BLR tracer (and indicator parameters, should they be present). Wells at this location will help define the northern boundary and vertical extent of the perched water zones and will help identify the hydraulic connection between the river and the perched water zones.

4.1.1.2 Sewage Treatment Lagoon Well Set. This well set will be located southwest of the sewage treatment lagoons (see Figure 4-1). It will provide sampling locations in the northeastern portion of INTEC within the alluvium (where perched water may have developed in the alluvium as a result of flow in the BLR or discharge from the sewage treatment lagoons) and in the upper and lower perched water. The set will be placed in a location near the sewage treatment lagoons where no monitoring wells in the perched water currently exist. This well set will serve as the alluvium/basalt interface, upper perched water and lower perched water-monitoring points for the tracers. The wells at this location will help define the vertical depth and the northeastern boundary of the perched water zones. They will also provide information on the hydraulic connection between the river, the sewage treatment lagoons, and the perched water zones.

4.1.1.3 Percolation Pond Well Set. This well set will provide a location for sampling perched water that has developed in the alluvium and in the upper and lower perched water as a result of wastewater disposal in the percolation ponds (see Figure 4-1). The wells will be placed north of the percolation ponds at a location where no monitoring wells in the alluvium currently exist. (Upper perched water wells exist to the north and south, and one lower perched water well exists to the north.) This well set will provide monitoring points for the tracer introduced into the percolation ponds (and indicator parameters, if they are present). These wells will help identify the locations and vertical depth of the perched water and provide information on the hydraulic connection between the percolation ponds and the perched water zones.

4.1.1.4 Tank Farm Well Set. This well set will be located on the northwest corner of the tank farm (see Figure 4-1) and will include four wells: alluvium (9.0 to 13.7 m [30 to 45 ft]), upper perched water (36.6 to 42.7 m [120 to 140 ft]), lower perched water (115.6 to 128 m [380 to 420 ft]), and aquifer skimmer (approximately 140 m [460 ft]). The location for this well set was selected to provide a monitoring point between the BLR and the tank farm and to access contaminated water that might move to the northwest from the tank farm. These wells will help define effects of the BLR flow on the perched water at the alluvium/basalt interface, in both perched water zones and in the SRPA.

4.1.1.5 Central Well Set. This well set will be in a central location between the north and south perched water bodies (see Figure 4-1). The set will provide monitoring points for the shallow perched water and deep perched water zones at depths of approximately 120 to 140 ft bgs and 380 to 420 ft bgs, respectively. As nearby perched water wells (MW-11, MW-11P) have been dry at recent measurement events, the tensiometer and lysimeter data collected from this location will provide valuable information.

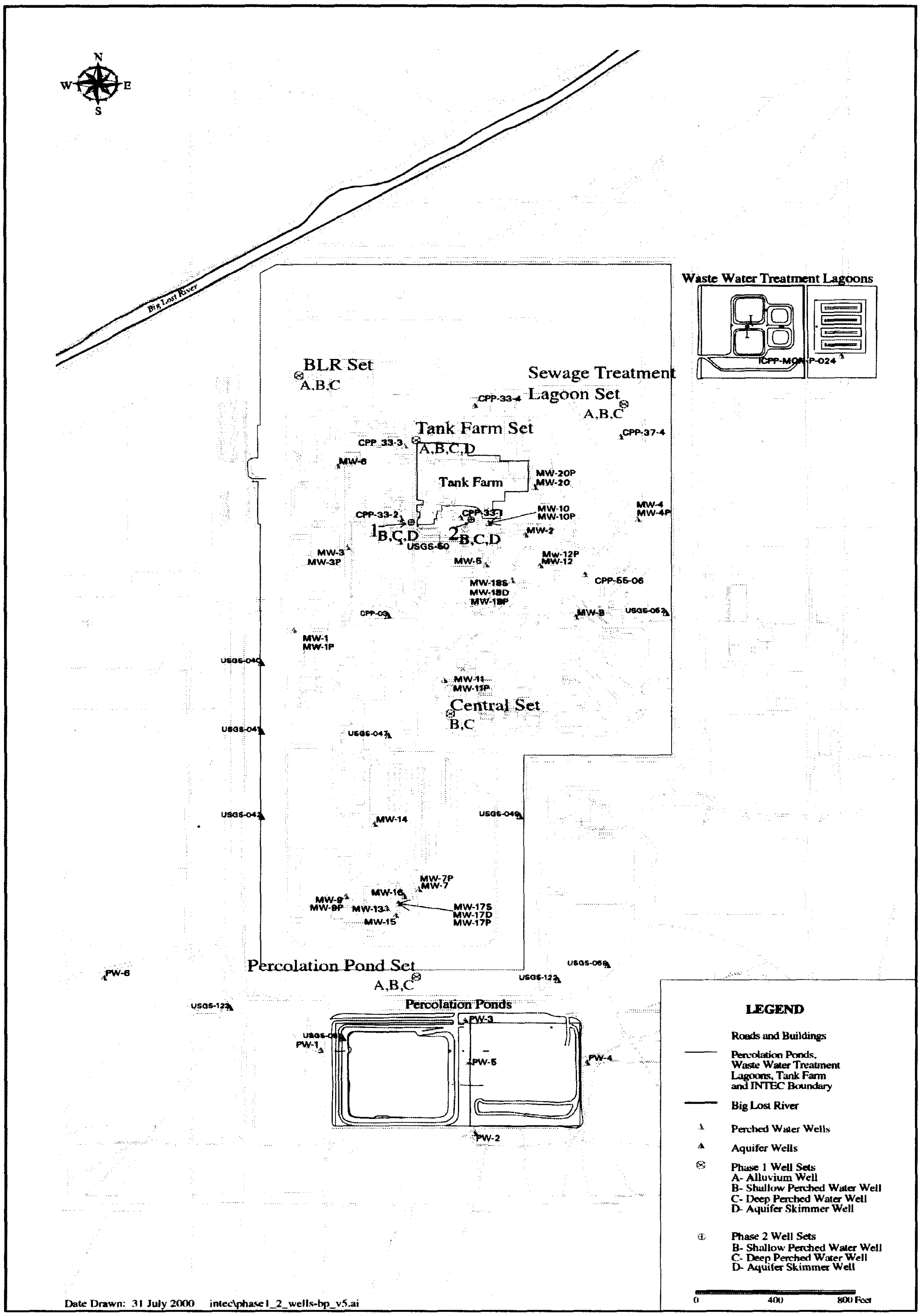

Figure 4-1. Map of INTEC showing existing and proposed well locations.

4.1.2 Phase II Wells

The Phase II wells will provide moisture monitoring and contaminant of concern (COC) sampling locations for monitoring the perched water drain-out and flux to the Snake River Plain Aquifer (SRPA). All well sets will contain at least three wells, one to be completed in the upper perched water zone, another to be completed in the lower perched water zone, and a third to be completed in the SRPA. Wells at these depths will be instrumented with tensiometers for measuring soil matric potential and with piezometers and lysimeters for collecting water samples for COC analysis. The aquifer skimmer wells will be screened across the water table. Actual completion depth to the bottom of the screen will be slightly below the SRPA water table (~140 m [460 ft]). The skimmer wells will be used for sampling aquifer water to determine contaminant flux out of the vadose zone.

The criteria for selection of Phase II wells includes the following:

- Placement near known significant recharge sources such as the percolation ponds, the BLR, and the sewage treatment lagoons (all the Phase I wells)
- Placement near known areas of significant surface contamination, for example, the tank farm
- Placement inside the known perched water zones, away from the edges
- Placement near areas where perched water in the alluvium may develop
- Placement near areas where existing wells indicate elevated contamination levels in the perched water, for example, MW-18, MW-20, MW-10, MW-5, and MW-2.

4.1.2.1 Well Set #1. Well set #1 will be located on the southwest corner of the tank farm (see Figure 4-1) and will include three wells: the upper and lower perched water zones and the SRPA. The location is between the tank farm and the old injection well, a past source of contaminated recharge. The alluvial well will be used to detect perching at the alluvial/basalt interface, should it occur. Currently, the closest monitoring points are CPP-33-2 and USGS-50. CPP-33-2 monitors only the shallow perched water. Although USGS-50 monitors the deep perched zone, the water from this well may have been compromised due to past use for service waste injection during injection well repair.

4.1.2.2 Well Set #2. Well set #2 will be located directly south of the tank farm (see Figure 4-1) and includes three wells targeting both the upper and lower perched water zones and the SRPA. An alluvial well is not planned for this location based on the lack of moisture found at the alluvium/basalt interface in nearby wells. Should water be found during drilling at this location an alluvial well can be added. The location is down gradient from the tank farm, between the tank farm release sites of CPP-28 and MW-18. MW-18 has high contaminant levels in the upper perched, lower perched, and aquifer wells. Well Set #2 will help to determine the source of contamination. Its location is also near wells MW-10, MW-5 and MW-2, all with elevated Sr-90 levels when sampled in 1995. It is in a crucial location for gathering moisture data that might support efforts to prevent contaminant flux from reaching the SRPA.

4.2 Monitoring and Sampling Locations

The following discussion includes locations for the sampling of the perched water and monitoring water level measurements, matric potentials, and soil moisture content.

4.2.1 Perched Water Sampling Locations.

A discussion of the new wells to be included is provided above (Section 4.1). These wells are listed in Table 4-1. All existing perched water wells will also be sampled as part of the Phase I and II monitoring networks. However, some of the wells may never be suitable for sampling or at best can be sampled only during "wet" times because they are either permanently or seasonally dry. The characteristics of many of the existing wells are not currently understood because they have not been monitored for extended periods of time. Table 4-2 is a listing of INTEC perched water wells and piezometers. Prior to any sampling under this plan, water level measurements will be taken to determine the suitability of each individual well.

Most of the existing perched water wells do not have dedicated pumps, the exceptions being PW-1, PW-4, PW-5, and USGS-50. These wells are equipped with 2-in. rediflow pumps. Dedicated pumps may be installed in perched water wells where there is sufficient water. In addition to well completion information, Table 4-2 lists the most current (FY-99) measured water levels and calculated purge volumes. The actual water levels in some of these wells have not been measured even though the wells are believed to have water in them. In the cases where the water level is unknown, no purge volume has been calculated. Four of the 47 wells and piezometers target the lower perched water; the rest are completed in the upper perched water zones.

Suction lysimeters to be installed under this FSP will be used to collect soil-pore water samples. In addition to the suction lysimeters installed under this FSP, a survey will be conducted to identify whether any of the suction lysimeters currently installed are in working order. If any are found and are in working order they will be evaluated whether to be added to the existing monitoring network. Locations known to contain suction lysimeters include wells 33-2, 33-3, 33-5L, and A-60 through A-66.

4.2.2 Perched Water Level Monitoring Locations

All existing perched water wells (that are not permanently dry) and all new wells drilled under this FSP will be included in the water level monitoring network during Phase II. If the BLR contingency is not required, the network may be reduced in number and/or frequency following the decision on the BLR contingency. If the BLR contingency is adopted, other wells may be added to the monitoring network.

4.2.3 Soil Moisture Monitoring Locations

Soil moisture and matric potential measurements will be taken in the monitoring well network (Phase I and II wells). None of the existing perched water wells are instrumented to permit moisture data collection. Figure 4-1 is a map showing the locations of the proposed Phase I and the Phase II wells to be installed under this FSP.

4.3 Well Installation

Phase I drilling will consist of the installation of 15 wells. These wells will be drilled in sets of two to four as discussed in Section 4.1.1. Phase II drilling will consist of the installation of an additional six wells. Placement of these wells will be primarily around the Tank Farm; however, final placement of the Phase II wells be based, in part, on the results of the Phase I activities. Table 4-1 and Figure 4-1 summarize the location, completion details, and data to be collected during each phase of drilling.

Table 4-1. Phase I and proposed Phase II wells that will be installed to support the Group 4 sampling and monitoring.

PHASE I WELLS			
Phase I Wells	Depth (ft bgs)/target[a]	Instrumentation[a]	Data Types[a]
Big Lost River A	45 Alluvium	2-in. piezometer, lysimeter, tensiometer	Perched water, soil-pore water, matric potential
Big Lost River B	120 to 140 Upper perched zone	2-in. piezometer, lysimeter, tensiometer, moisture sensor	Perched water, soil-pore water, matric potential, moisture content
Big Lost River C	380 to 420 Lower perched zone	4-in. piezometer, lysimeter, tensiometer, moisture sensor	Perched water, soil-pore water, matric potential, moisture content
Sewage Lagoon Treatment A	45 Alluvium	2-in. piezometer, lysimeter, tensiometer	Perched water, soil-pore water, matric potential
Sewage Lagoon Treatment B	120 to 140 Upper perched zone	2-in. piezometer, lysimeter, tensiometer, moisture sensor	Soil-pore water, matric potential, moisture content
Sewage Lagoon Treatment C	380 to 420 Lower perched zone	4-in. piezometer, lysimeter, tensiometer	Perched water, soil-pore water, matric potential, moisture content
Percolation Pond A	45 Alluvim	2-in. piezometer, lysimeter, tensiometer	Perched water, soil-pore water, matric potential
Percolation Pond B	120 to 140 Upper perched zone	2-in. piezometer, lysimeter, tensiometer, moisture sensor	Perched water, soil-pore, water, matric potential, moisture content
Percolation Pond C	380 to 420 Lower perched zone	4-in. piezometer, lyimeter, tensiometer, moisture sensor	Perched water, soil-pore water, matric potential, moisture content
Central B	120 to 140 Upper perched zone	2-in. piezometer, lysimeter, tensiometer, moisture sensor	Perched water, water, matric potential, moisture content
Central C	380 to 420 Lower perched zone	4-in. piezometer, lysimeter, tensiometer, moisture sensor	Perched water, soil-pore water, matric potential, moisture content
Tank Farm A	45 Alluvim	2-in. piezometer, lysimeter, tensiometer	Perched water, soil-pore water, matric potential
Tank Farm B	120 to 140 Upper perched zone	2-in. piezometer, lysimeter, tensiometer, moisture sensor	Perched water, soil-pore, water, matric potential, moisture content
Tank Farm C	380 to 420 Lower perched zone	4-in. piezometer, lyimeter, tensiometer, moisture sensor	Perched water, soil-pore water, matric potential, moisture content

Table 4-1. (continued).

Tank Farm D	450 to 500 Aquifer	6-in. well	SRPA water
	PROPOSED PHASE II WELLS		
Phase II Wells	Depth (ft bgs)/target	Instrumentation	Data Types[a]
1-B	120 to 140 Upper perched zone	2-in. piezometer, lysimeter, tensiometer, moisture sensor	Perched water, Soil-pore water, matric potential
1-C	380 to 420 Lower perched zone	4-in. piezometer, lysimeter, tensiometer, moisture sensor	Perched water, Soil-pore water, matric potential
1-D	450 to 500 Aquifer	6-in. well	SRPA water
2-B	120 to 140 Upper perched zone	2-in. piezometer, lysimeter, tensiometer, moisture sensor	Perched water, soil-pore water, matric potential
2-C	380 to 420 Lower perched zone	4-in. piezometer, lysimeter, tensiometer, moisture sensor	Perched water, soil-pore water, matric potential
2-D	450 to 500 Aquifer	6-in. well	SRPA water

a. The well completion depth and depths that instrumentation will be installed in the Phase I and II wells will be determined following geophysical borehole logging of the deepest hole in a particular set. The intent is to complete and instrument the hole in the primary perched water zone and set additional instrumentation in other perched zones should they be identified by the geophysical logging.

The locations shown on Figure 4-1 are the approximate location for the center of the well sets. The wells at each set will be located approximately 25 feet (7.6 m) apart to reduce the possibility of borehole intersections at depth and interference of borehole seal materials between boreholes. Sites will be cleared for utilities and obstructions prior to drilling. Following final site selection, the site will be surveyed to establish the final drilling location. Because final completion depth will be determined in the field, depths listed in Table 4-1 are only estimated values.

Borehole lithology, geophysical, and radiological screening logs will be generated from the deepest well at each set. Other boreholes within a set may also be logged at the discretion of the field team leader/field geologist. Well logging (hole deviation, caliper, natural gamma, density, neutron, gamma-gamma, video, high-resolution gamma spectroscopy, alpha/beta spectroscopy) will be completed over the entire depth of the borehole and will be used to guide the drilling, sampling, and completion depths of the other vadose zone wells at that set. The exact sampling locations for interbed sediment samples will be dependent upon the lithology encountered in each borehole and will be decided in the field.

4.3.1 Drilling Methods.

Each well set will be drilled with a combination of wire-line coring and dual-wall, reverse-circulation, air-rotary drilling. The deepest borehole in each well set will be drilled first, with continuous core collection from ground surface to total depth. As perched water zones are encountered, casing will be installed and sealed in place. This is required to prevent contaminant movement to lower, possibly cleaner, perched zones, as the borehole is being advanced. The borehole will be then advanced with a smaller bit. The surface casing will be of sufficient diameter to allow for 3 casing reductions before reaching total depth.

Table 4-2. INTEC perched water wells that contained water during recent measurement events.

Well Name	Well Alias	Water Level[a] (ft)	Date Measured	Casing Diameter (in.)	Well Depth (ft)	Well Screen Material	Well Screen (ft)	Well Status (1999)	3-Borehole Volumes (gal)
CPP-33-1	33-1	113.6		2	113.6	Stainless Steel	89 to 99	dry	0
CPP-33-2	33-2	101.56	12/3/98	2	114.8	Stainless Steel	85.8 to 105.8	wet	4
CPP-33-3	33-3	116.14	12/3/98	2	126.4	Stainless Steel	111.8 to 1222.0	wet	3
CPP-33-4	33-4	105.1	12/3/98	2	124	Stainless Steel	98.2 to 118.5	wet	8
CPP-37-4	37-4	104.78	12/3/98	2	113.4	Stainless Steel	99.9 to 109.9	wet	3
CPP-55-06	55-06	109.02	12/3/98	2	114.6	Stainless Steel	93.1 to 113.1	wet	6
INTEC-MON-P-001	MW-1	336.3	12/3/98	4	336.3	PVC	326 to 336	wet	0
INTEC-MON-P-001	MW-1	Unknown[a]		1	368.3	PVC	359 to 369	wet	0
INTEC-MON-P-002	MW-2	112.3	12/3/98	2	112.3	PVC	102 to 112	dry	0
INTEC-MON-P-003	MW-3	138.3	12/3/98	2	138.3	PVC	128 to 138	dry	0
INTEC-MON-P-003	MW-3	119	12/3/98	1	119	PVC	116.3 to 118	dry	0
INTEC-MON-P-004	MW-4	110.8	12/3/98	2	110.8	PVC	100.6 to 110.6	dry	0
INTEC-MON-P-004	MW-4	130.7	12/3/98	1	130.7	PVC	128 to 129.7	dry	0
INTEC-MON-P-005	MW-5	107.22	12/3/98	2	126.7	Stainless Steel	106.5 to 126.5	wet	11
INTEC-MON-P-005	MW-6	83.7	12/3/98	1	83.7	PVC	81.0 to 82.7	unknown	2
INTEC-MON-P-006	MW-6	117.26	12/3/98	2	137	PVC	117 to 137	wet	5
INTEC MON-P-007	MW-7	107	12/3/98	1	105	PVC	102.3 to 104	dry	0
INTEC-MON-P-007	MW-7	140.74	12/3/98	2	142.3	PVC	132 to 142	wet	1
INTEC-MON-P-008	MW-8	127	12/3/98	2	127	PVC	115 to 125	dry	0
INTEC-MON-P-009	MW-9	128	12/3/98	2	132	PVC	120 to 130	wet	1
INTEC-MON-P-009	MW-9	107	12/3/98	1	108	PVC	104.2 to 105.7	dry	0
INTEC-MON-P-010	MW-10	78	12/3/98	1	78.2	PVC	76.5 to 78	dry	0
INTEC-MON-P-010	MW-10	Unknown[a]		2	152	PVC	141 to 151	wet	0
INTEC-MON-P-011	MW-11	116	12/3/98	1	116	PVC	112 to 113.5	dry	0
INTEC-MON-P-011	MW-11	138	12/3/98	2	138	PVC	131 to 136	dry	0
INTEC-MON-P-012	MW-12	113.5	12/3/98	2	113.5	PVC	109 to 119	dry	0
INTEC-MON-P-012	MW-12	151.75	12/3/98	1	151.75	PVC	148.55 to 150.25	dry	0

Well Name	Well Alias	Water Level[a] (ft)	Date Measured	Casing Diameter (in.)	Well Depth (ft)	Well Screen Material	Well Screen (ft)	Well Status (1999)	3-Borehole Volumes (gal)
INTEC-MON-P-013	MW-13	104	12/3/98	2	105.4	PVC	100 to 105	dry	0
INTEC-MON-P-014	MW-14	104	12/3/98	2	104	PVC	94 to 104	dry	0
INTEC-MON-P-015	MW-15	123	12/3/98	2	131.6	PVC	111.3 to 131.3	dry	0
INTEC-MON-P-016	MW-16	112.2	12/3/98	2	112.2	PVC	97 to 107	dry	0
INTEC-MON-P-017	MW-17	185	12/3/98	2	193.3	PVC	181.7 to 191.7	wet	1
INTEC-MON-P-017	MW-17	273.8	12/3/98	1.25	274	PVC	263.8 to 273.8	dry	0
INTEC-MON-P-017	MW-17	381	12/3/98	OH[b]	381	Open Hole	360 to 381	wet	0
INTEC-MON-P-018	MW-18	124	12/3/98	2	124.2	PVC	113.5 to 123.5	dry	0
INTEC-MON-P-018	MW-18	392	12/3/98	1.25	412	PVC	394 to 414	wet	9
INTEC-MON-P-020	MW-20	106.7	12/3/98	1	106.7	PVC	96 to 106	dry	1
INTEC-MON-P-020	MW-20	135	12/3/98	2	151.5	PVC	133.2 to 148.4	wet	6
INTEC-MON-P-024	MW-24	58	12/3/98	4	123	Stainless Steel	53.5 to 73.5	wet	2
PW-1	PW-1	71.68	1/25/99	6	120	Steel	100 to 120	wet	225
PW-2	PW-2	122.21	10/21/98	6	131	Steel	111 to 131	wet	36
PW-3	PW-3	118.2	4/13/98	6	125	Steel	103 to 123	wet	67
PW-4	PW-4	83.3	1/19/99	6	150	Steel	110 to 150	wet	308
PW-5	PW-5	72.49	10/22/98	6	131	Steel	109 to 129	wet	270
PW-6	PW-6	123.84	1/14/99	6	130	Steel	105 to 125	wet	16
USGS-050	USGS-050	376.3	1/12/99	OH[b]	405	Open Hole	357 to 405	wet	128
USGS-081	USGS-081	93.19	12/21/98	OH[b]	104.3	Open hole	26 to 104.3	dry	0

pvc = ployvinyl chloride

a = Water level data from recent monitoring events, primarily from 1998 or 1999. For wells with "unknown" water levels, this indicates that the measurement device may have been wet or moist upon retrieval, but no measureable water level was encountered.

b = Open hole completion.

Each additional borehole at a well set will be drilled using this reverse-air-rotary method. This allows for rapid drilling to the target depth established from the logging of the deep borehole. Unless determined in the field by the FTL or field geologist, no cores will be collected from subsequent holes.

The corehole will be advanced with a standard coring until the top of the targeted sedimentary interbed is encountered. Extreme caution will be used so that as little as possible of the interbed is breached upon first contact. At this point the face discharge bit will be changed over to a spring-loaded advance push-bit system with a lexan liner. Rock cores above and below interbeds will be collected in standard split-barrel sampling tubes. As the core barrel is recovered it will be surveyed by the RCT. After the RCT verifies no external contamination, the core barrel will be opened and the lexan liner and the core surveyed by the RCT. If the RCT detects contamination on either the core barrel or core then appropriate actions will be taken as directed by the RCT. Field logging by the field geologist will follow RCT survey of the core. After logging of the core material, the lexan liner will be capped with plastic end caps. The liner may also be cut to shorter lengths as needed for various analyses After the core has been logged it will be placed into standard corrugated core storage boxes.

After push-coring through the interbed, the advance bit will be removed and standard coring will resume to the next interbed. This process of alternating standard and advance-bit coring will continue until total depth of the hole is reached. After reaching the target total depth, each corehole deep boring will receive a complete suite of physical and geophysical downhole geologic logs.

Care will be taken to assure no drilling or sampling equipment other than the sample split barrel or lexan liner will come in contact with the sample material prior to, during, or after sample collection. All procedures and drilling and sampling equipment will be designed to minimize the release of any contamination to the environment. All activities will be conducted in accordance with MCP-226, "Well Construction/Well Abandonment" (INEEL 1999a) and MCP-3653, "Well Construction, Modifications, Compliance, and Management" (INEEL 1999b).

4.3.2 Materials.

Upon completion of all downhole activities the open boreholes will be equipped with instrumentation to provide for long term monitoring of vadose zone moisture and the collection of pore water samples. Results of the borehole logging will be used to determine the exact placement of the instrumentation. Each borehole will be equipped with a combination of tensiometers, suction lysimeters, and moisture sensors. Exact type and number of these instruments will depend on conditions encountered. In addition, all upper and lower perched water wells may have peizometers (2-inch for upper; 4-inch for lower) installed. The aquifer wells will be completed as 13-cm (6-in.) wells.

High pressure-vacuum lysimeters will be used for this project. Where perched water is present, lysimeters will be installed for sampling at a later date. These lysimeters consist of a two-section cup assembly. The lower chamber is a standard porous cup where soil moisture enters the unit. The upper portion is a sampling chamber separated by a check valve from the lower portion. Sample is collected by pulling a vacuum greater than the surrounding matric potential on the upper and lower chambers. Pore water then migrates into the porous stainless steel cup and passes through the check valve into the upper chamber. To retrieve a sample, pressure is applied to the upper chamber, using an inert gas, closing the check valve to the lower chamber and forcing the sample up the sample discharge line to the surface.

For shallow perched zones 2-in. piezometers will be used where possible. For deep perched zones the casing size increases to 4-in. Dedicated submersible pumps may be installed in perched water wells, if appropriate, also with a stainless steel discharge line. Motor size for those pumps will be determined based on the depth to water. Figure 4-2 shows a typical aquifer well installation. The SRPA wells will be

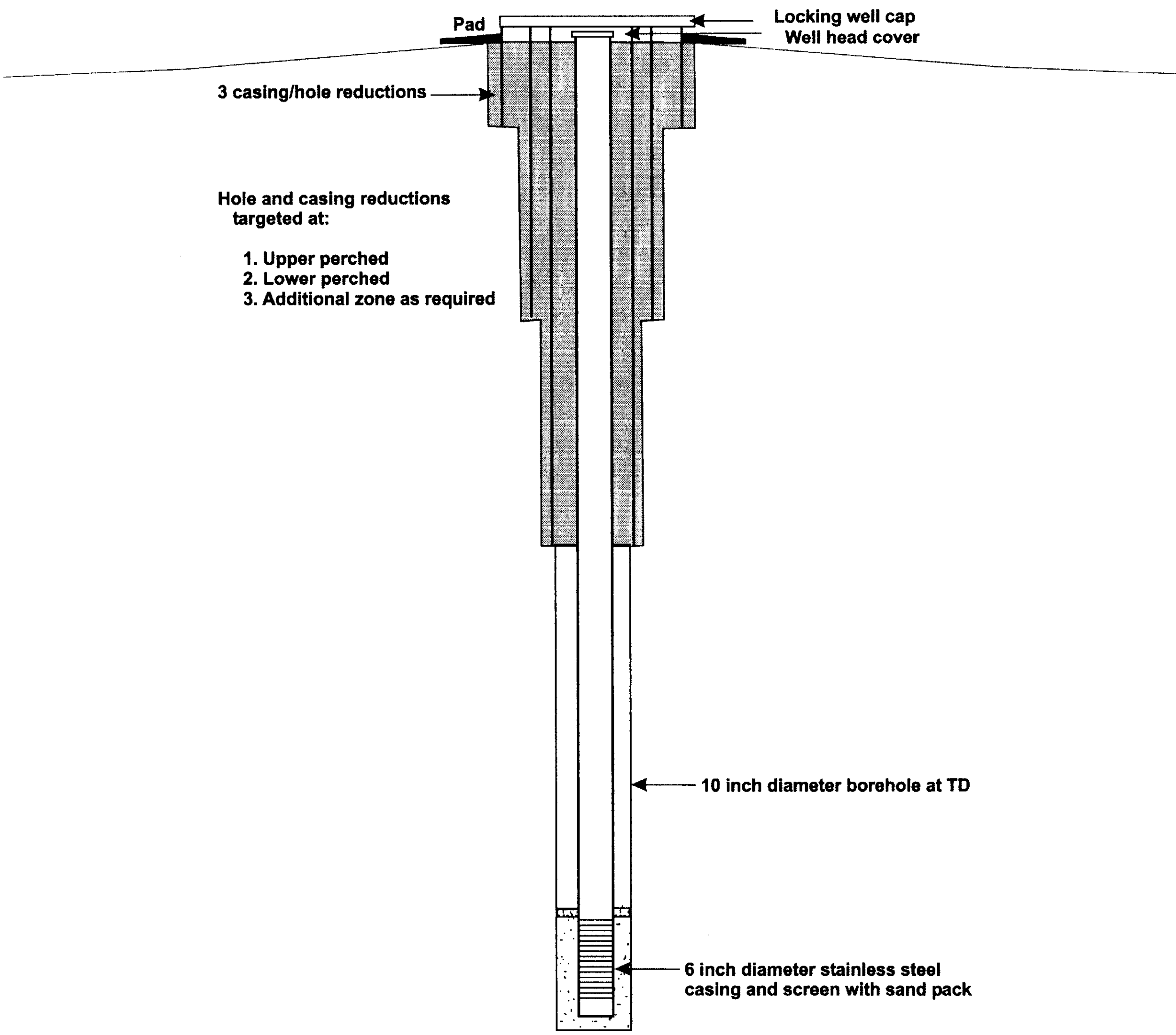

Figure 4-2. Conceptual diagram for aquifer well completion.

constructed with minimum 6-in. 304 stainless steel 40-slot screen and Schedule 10 casing. A dedicated 3 – 5 horsepower (HP) submersible pump will be installed with a stainless steel discharge line.

Existing perched zone wells will receive instrumentation appropriate with their intended use. At a minimum, this will include pressure transducers in all existing perched wells that currently have water in them. Pressure transducers measure the water pressure above the instrument. By knowing the depth at which the transducer is set this pressure can be converted to a water depth below ground surface with a simple calculation. The pressure rating required will be determined in the field based on the maximum water column in a piezometer or well. Other equipment that may be installed includes dedicated pumps.

4.3.3 Borehole Instrument Installation.

Upon completion of all downhole activities the open boreholes will be equipped with instrumentation to provide for long-term monitoring of vadose zone moisture and for the collection of pore water samples. Each borehole will be equipped with a combination of tensiometers, suction lysimeters, and moisture sensors. Exact type and number of these instruments will depend on conditions encountered. Other moisture sensor instruments (i.e., moisture blocks) may be installed based on field conditions and as space allows. A 5-cm (2-in.) piezometer will be installed in the upper perched water and a 10-cm (4-in) piezometer in the lower perched water.

All tensiometers and lysimeters will be cleaned, assembled, and tested as directed by the manufacturer's instructions and by TRP-EM-GW-97 (BBWI, 2000). In general, porous cups will be cleaned by allowing one (1) liter (33 oz.) of 8N hydrochloric acid to permeate each cup. This is followed by a distilled water rinse of 15 to 20 liters (4 to 5 gal). The distilled water rinse can be accelerated by applying a 20 psi to 30 psi pressure to drive the water through the cups' porous material. Following cleaning, the units will be assembled and tested for leaks. Testing will consist of placing the porous cup and instrument joints in a tank of water (an aquarium works well) and slowly applying a positive pressure (normally 15 psi [1.02 atm]) per the manufacturer's recommendation. Cups should not bubble until at least 15 psi. After testing, the units will be wrapped in clean plastic and transported to the field.

If possible, moisture sensors will be installed with the tensiometers and lysimeters, but before placement of the silica flour. Lowering the instrument bundle to slightly below the appropriate depth places the moisture sensor. The instrument bundle is pulled up to force the sensor against the wall of the borehole. At this time the sensor is tested for proper functioning. If it is functioning properly, then silica flour is placed around the instrument bundle. If it is not functioning properly, then the bundle is removed to the surface and repaired or replaced.

Multiple tensiometers may be installed at various depths within each borehole. Exact depths will be determined in the field based on borehole logging results. Where possible, two (2) tensiometers will be placed per borehole, one at or below the interbed and one at the top of the interbed (see Figures 4-3a, 4-3b, and 4-3c). Tensiometers will be placed in the open borehole, then surrounded by silica flour slurry. This slurry will be emplaced via a 1-inch tremie pipe set directly above the tensiometer. A granular bentonite plug will be placed between the tensiometers. Granular bentonite will also be used to seal the open borehole from the last tensiometer/lysimeter placement to the ground surface.

Suction lysimeters are installed in a manner similar to the tensiometer. They will be placed such that the porous stainless steel sample cup is located at approximately the top of the interbed. The porous stainless steel cup will then be surrounded by silica flour slurry. Exact depths will be determined in the field based on borehole logging results.

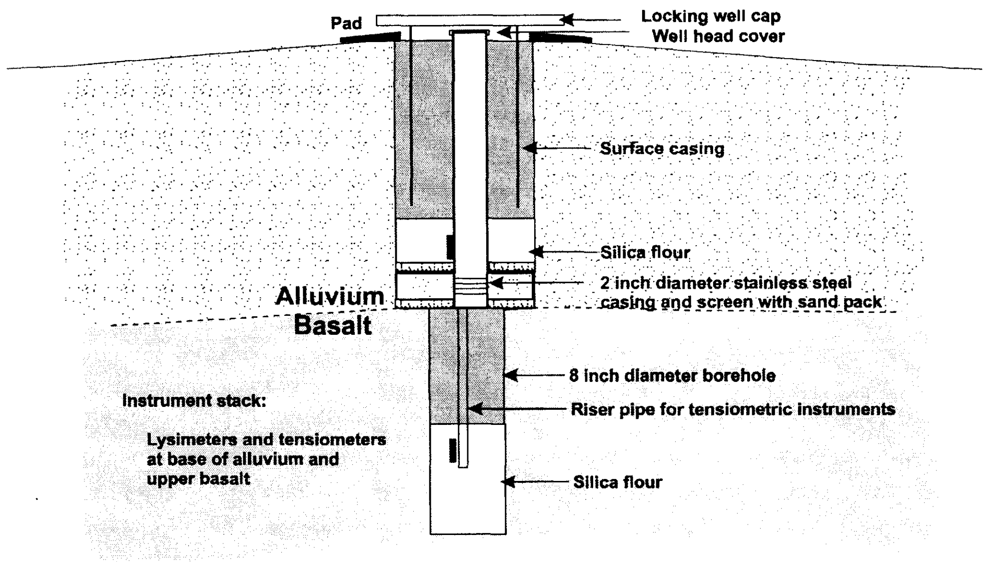

Figure 4-3a. Conceptual diagram for allivium zone instrument installation.

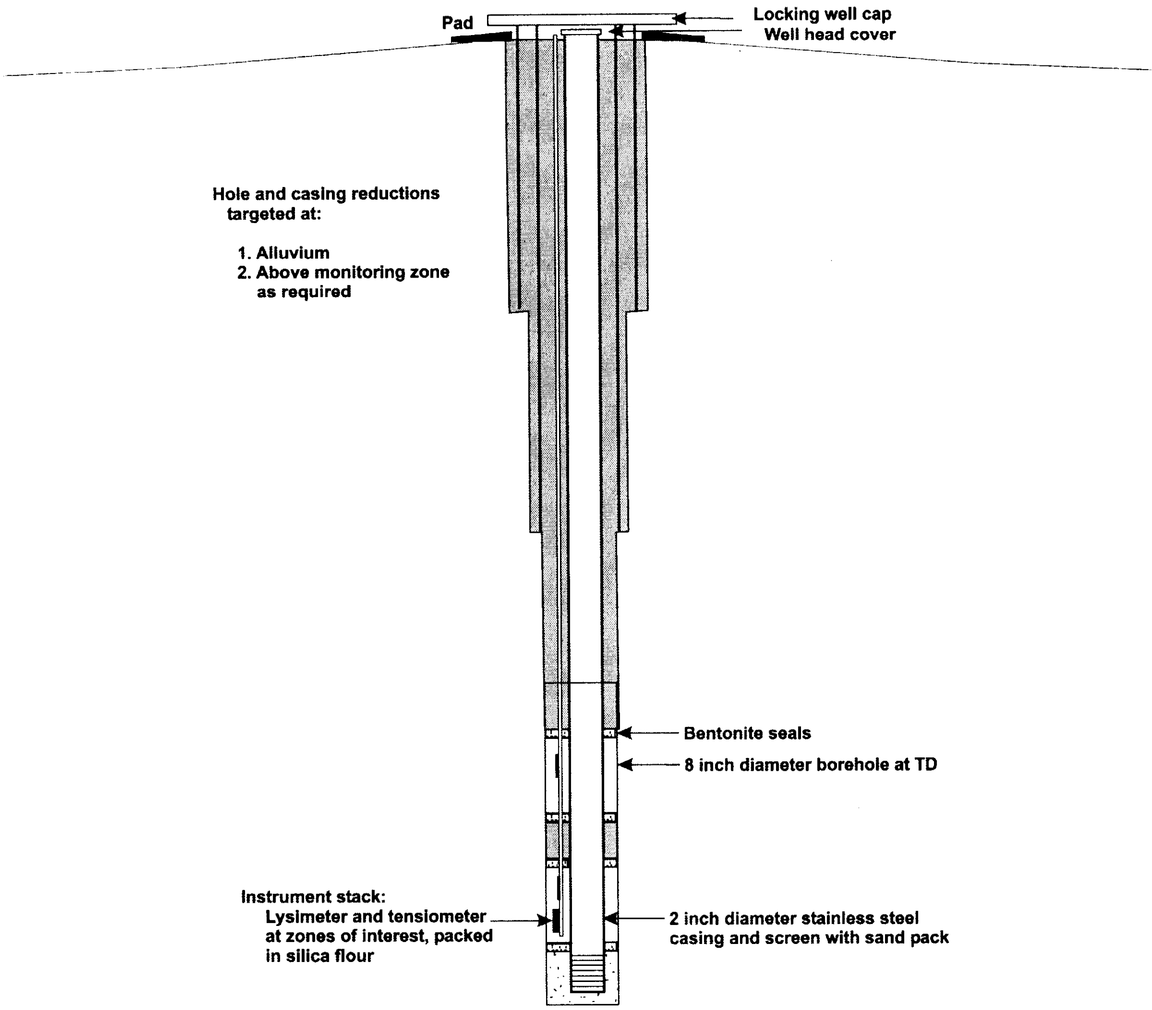

Figure 4-3b. Conceptual diagram for shallow perched water zone instrument installation.

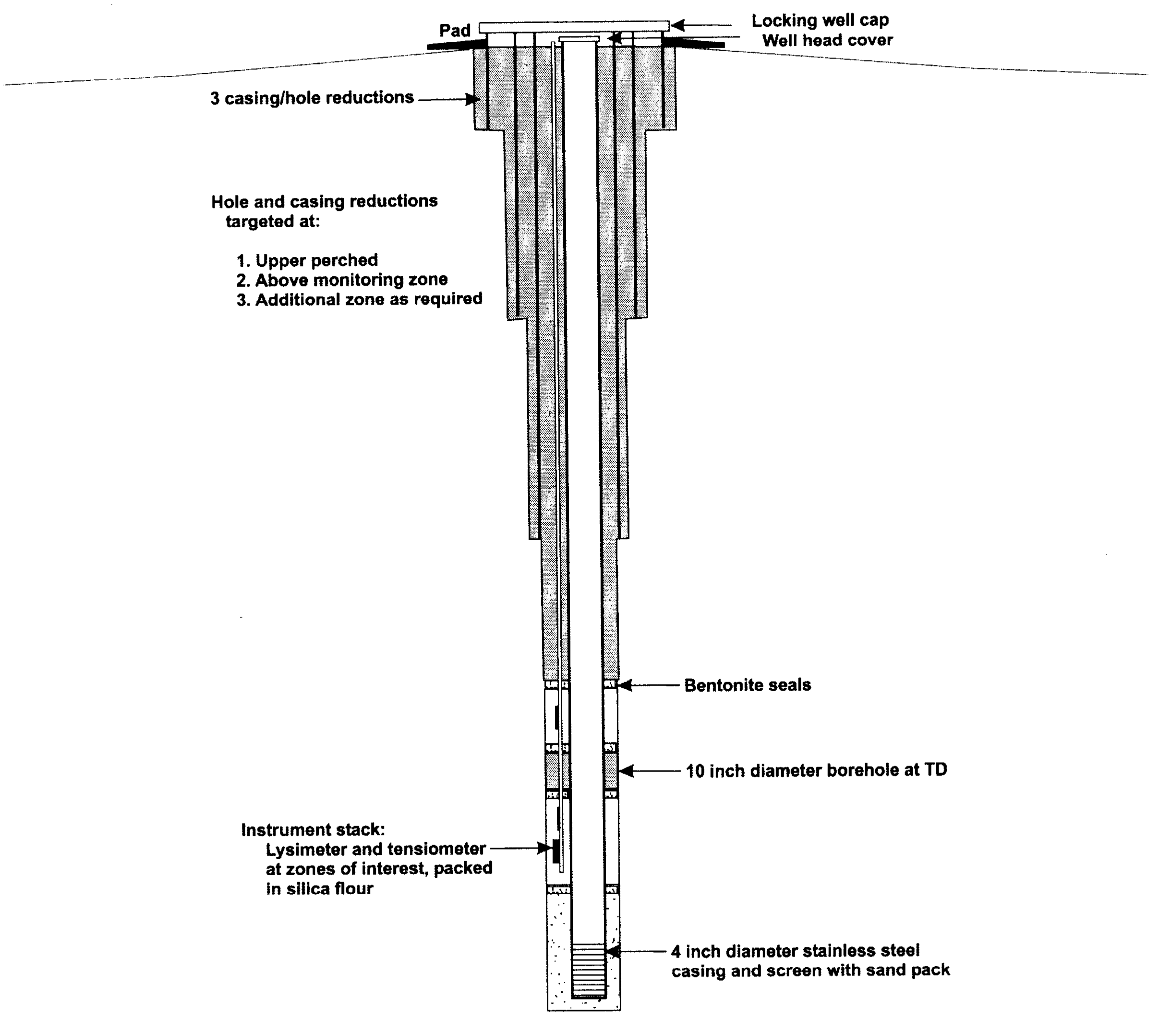

Figure 4-3c. Conceptual diagram for deep perched water zone instrument installation.

The aquifer wells and piezometers will be constructed in the same way, except that only casing sizes will vary. After reaching the target depth and upon completion of geophysical logging (in the deep borehole) the screen and casing will be lowered into the open borehole. For aquifer wells, it is anticipated that 7.6 m (25 ft) of screen with a 1.5 m (5-ft) sump will be used. The screened interval will extend 1.5 m (5 ft) above the static water table. The bottom of the screen will extend across the first fractured interval. The exact screen length will be determined in the field. After placing the screen/casing assembly the annular space around the screen will be filled with clean silica sand as a filter pack. Sand will extend to approximately fivefeet above the top of the screen. A 1.5-m (5-ft) granular bentonite plug will be placed on the filter pack and hydrated. After full hydration of the bentonite the remaining annulus will be filled with a non-shrink cement grout. Piezometers will be installed in a similar manner. The screen bottom will be placed as close as practical to the top of the interbed. Either a bentonite seal or non-shrink grout may be used to seal the annulus.

Standard pressure transducers will be installed in all existing and new perched wells that have water in them. Transducers will be set after depth to water has been determined. Transducer cables will be measured and the transducer lowered into the piezometer to a depth that will allow for accurate head readings, but not to exceed the maximum pressure rating of the transducer. Care will be taken to assure that the transducer remains vertical and does not lie on the bottom of the well. Transducer accuracy will be verified using a water level probe.

All downhole instruments will be attached to a data logger at the surface. The data logger will allow for automated recording of various instrument values. Initially, tensiometer and moisture sensors will be read daily. Exact set up (24-hourly average or one time reading) will be determined in the field after proper instrument operation is verified.

4.3.4 Surface Completion.

Each well head will be finished with a 0.9 × 0.9 × 0.5 m (3 × 3 × 1.5 ft) cement pad around the surface casing, sloped away from the well. A brass survey pin will be set in the wet cement in the northeast corner of the pad. The interior of the surface casing will contain a well seal with access/exit ports for each instrument installed in the borehole. A locking well cover will be installed.

4.3.5 Well Development.

All aquifer wells installed under this FSP will be developed by pumping the well until the water discharge is clear and free from suspended sediments. According to past experience at the INEEL, this process usually takes only several minutes, is accomplished before a single well volume is evacuated, and can therefore be accomplished in conjunction with purging the monitoring well for the first sampling event. A record will be kept of field parameters during purging, and will also serve to document the development of the well. A full discussion of purging can be found in Section 4.5.2.

Perched water wells installed under this FSP that have standing water in them will also be developed, however, the methods used will vary. For wells that can supply an adequate yield of water, as determined during drilling process, the development will be conducted as described above. Wells deemed incapable of supplying water in amounts to support pumping, but still containing standing water, will be developed by bailing the well until three well volumes are removed or the well goes dry. Because the amounts of perched water flowing to wells can be quite low, recovery may be quite slow, therefore, if a well is bailed dry, development will stop and the well will be considered developed.

4.3.6 Drilling and Sampling Equipment Decontamination.

All drilling equipment will be steam cleaned prior to entering the work area. Drilling equipment will be decontaminated between sets to ensure no cross-contamination among sites. Sampling equipment (inner barrels, quad latches, etc.) will be field cleaned between sampling runs. All downhole equipment (bits, drill pipe) used at a site will be decontaminated between boreholes. Instrumentation that is to be sent downhole (i.e., PVC pipe, stainless screen and casing) will also be steam cleaned prior to installation. Materials supplied in sealed bags from the manufacturer and certified as clean will not require additional steam cleaning. If, however, the packaging for this material has been significantly breached (i.e., the material is exposed) then it will require cleaning.

A central decontamination area will be established for this equipment decontamination. The decontamination area will consist of a portable, self-contained, decontamination pad. The portable decontamination pad will include equipment such as a steam cleaner, sump, and trash pump to the remove the decontamination fluids from the pad to a tank or container, as appropriate, with secondary containment. Typically, this pad and equipment are supplied and setup by the drilling subcontractor. The pad will be of sufficient size to so that the drill rig can be driven onto the pad and all decontamination fluids generated from steam cleaning are contained. Although not expected, in the event that high level radiological contamination of equipment is encountered (as defined in Table 2.2 of the INEEL Radiological Manual [PRD-183, Rev 6, 7/00] and at the discretion of the Radiological Control Technician at the drill site) the drilling equipment will be decontaminated at the decontamination facility located in CPP-659. If decontamination must occur in CPP-659, all wastes generated during the decontamination will be handled in accordance with the policies and procedures in place for the decontamination facility.

The decontamination methods for the drilling and sampling equipment will ensure maximum containment of decontamination fluids, minimization of waste, and minimize the chances of equipment contamination. Decontamination of the field equipment for this project will be performed as per Technical Procedure (TPR) 51, *Decontamination of Heavy Equipment in the Field,* (TPR-EM-GW-51, Draft, 2000) and TPR 52, *Decontaminating Sample Equipment in the Field* (TPR-EM-GW-52, Draft, 2000). Additionally, evaluation of decontamination measures will be made during drilling in "clean" areas (i.e., south end of plant), and necessary modifications made to ensure containment, proper waste segregation, and waste minimization procedures will be in place prior to the start of drilling at potentially contaminated sites (such as around the Tank Farm).

4.3.7 Sampling Location Surveys

After drilling, sampling, and installation of monitoring equipment, all borehole locations will be surveyed in accordance with the requirements set forth in MCP-227, "Sampling and Analysis Process for Environmental Management Funded Activities" (INEEL 1997a).

4.4 Subsurface Sediment Collection

This section details the actions that will be used for the drilling and interbed sediment collection from the deepest well at each well set. This may be an aquifer well or a deep perched well. Also discussed is the use of surface geophysics for the siting of the alluvial well sets.

4.4.1 Subsurface Sediment Sample Prioritization.

Due to the difficulties inherent in the collection of samples from sedimentary interbeds, that at some targeted interbeds a sufficient volume of sample material may not be available to meet all of the analytical needs. If there is insufficient sample material collected during initial coring of the deep hole, it may be supplemented with material collected by coring the same interval at the next hole of the set. Should insufficient sample material be recovered, the available sample material will be allocated to meet the following analytical requirements in the order listed below:

1. Soil physical and hydraulic characterization samples

2. Soil chemistry samples

3. Treatability studies/archive samples.

4.4.2 Samples for Physical/Geotechnical Analysis.

It is anticipated that three (3) samples will be collected from each interbed for physical/hydraulic analysis. Samples will be collected from the top, middle, and bottom of the interbed. Samples must be undisturbed for most of the requested analyses. Therefore, samples will be collected by cutting the lexan liner and capping the ends. Efforts will be made to minimize sample compaction during cutting and transport.

Physical and hydraulic analyses will consist of a moisture characterization curve, grain size distribution, moisture content, effective porosity, bulk density, and saturated and unsaturated hydraulic conductivity.

4.4.3 Samples for Chemical Analysis.

It is anticipated that samples for chemical analysis will be collected from the upper half of the interbed. All efforts will be made to collect chemical samples from saturated material when it exists. Per the above prioritization scheme, chemistry samples will be collected from immediately below the upper geotechnical sample. Samples may be collected by either cutting and capping the lexan liner, or transferring interbed material from the liner to appropriate jars. The final method will be determined through discussions with the analytical laboratory. Samples will be analyzed for COCs, TAL metals, and major cations and anions, cation exchange capacity, extractable iron, and soil pH.

4.4.4 Downhole Geophysical Logging.

Upon reaching the target depth each hole will receive a complete suite of physical and geophysical downhole geologic logs. At a minimum, this suite will consist of video, caliper, natural gamma, deviation, gamma-gamma, density, neutron, and high-resolution gamma spectroscopy. All geophysical logs will be used for comparison of information and to assist in the field determination of instrument placement. Upon completion of logging, the borehole instrumentation will be installed.

The INEEL field office of the USGS will perform the video, caliper, natural gamma, deviation, gamma-gamma, and neutron logs. BBWI personnel will perform high-resolution gamma spectroscopy logs. Geophysical logs involving a radioactive source (gamma-gamma, and neutron) will be conducted inside the core string prior to its removal from the corehole. All other logs will be done in the open borehole.

4.5 Groundwater Sampling

This section describes the sampling and monitoring procedures and equipment to be used for the Phase I, initial round of Phase II, and tracer test monitoring. Prior to the commencement of any sampling activities, a pre-sampling meeting will be held to review the requirements of the FSP and Health and Safety Plan (HASP) (BBWI 2000), and to ensure all supporting documentation has been completed.

4.5.1 Water Level Measurement

Prior to sampling any well or piezometer, depth to water will be measured using either an electronic sounding tape or a steel tape and chalk as described in SOP-11.9, "Measurement of Groundwater Levels" (INEEL 1993). Measurement of all water levels will be recorded to an accuracy of 0.01 ft.

4.5.2 Well Purging

All aquifer skimmer wells and perched water wells that have sufficient water will be purged prior to sample collection. Well purging is performed to remove stagnant water from the borehole in an attempt to draw in water more representative of the actual aquifer conditions prior to sampling. During the purging operation, a flow-through cell with a Hydrolab (or equivalent) water quality monitor will be used to measure specific conductance, pH, dissolved oxygen, and temperature. Well purging procedures are provided in BBWI, technical procedure (TPR)-EM-GW-56, "Sampling Groundwater" (BBWI 2000a). Wells will be purged to remove a minimum of three well casing volumes of water and when three consecutive water quality parameters are within the following limits:

Ph	$\pm$ 0.1
Temperature	$\pm$ 0.5°C
Specific conductance	$\pm$ 10 µmhos/cm.

Only after completion of well purging can a sample for water quality analysis can be collected. The perched water formation surrounding some of the wells may be inadequate to supply the full purge volume listed in Table 4-2. In this case, the well will be purged to dryness and allowed to recover to 90% of the original water level. After recovery, samples will be collected as directed in TPR-EM-GW-56.

4.5.3 Sample Collection

Before sample collection begins, all non-dedicated sampling equipment that is to come in contact with the water sample will be cleaned following the procedure outlined in INEEL SOP-11.5, "Field Decontamination of Sampling Equipment." Upon the completion of sampling, all non-dedicated equipment that came in contact with the well water will be decontaminated prior to storage per INEEL SOP-11.5, with the exception that the isopropanol steps for decontamination will be omitted.

Prior to purging, the water level in each well will be measured. The well will then be purged a minimum of three well-casing volumes until the pH, temperature, dissolved oxygen, and specific conductance of the purge water have stabilized, or until a maximum of five well-casing volumes have been removed. If the well goes dry prior to purging three casing volumes, purging will be considered complete and samples collected after 90% recovery in the well. If parameters are still not stable after five volumes have been removed, samples will be collected and appropriate notations will be recorded in the logbook.

Perched water samples will be collected for the analyses defined in Table 4-3. The requirements for containers, preservation methods, sample volumes, holding times, and analytical methods are provided in Table 4-4.

Sample bottles for perched water samples will be filled to approximately 90 to 95% of capacity to allow for content expansion or addition of preservation. The only exception to this is for VOC samples, for which no headspace is permitted. Samples to be analyzed for metals (TAL metals plus boron and strontium) will be collected as both unfiltered and filtered. Filtered samples will be passed through a 0.45 µm filter. Samples requiring acid preservation will be acidified to a pH < 2 using ultrapure nitric acid.

Table 4-3. Perched water analytes for Phase I and initial Phase II sampling of well network.

Cations	Anions	COCs	Hazardous Substances	Field	Conditional[a]
Calcium	Sulfate	Tritium	1,1,1-TCA	Temperature	Nitrogen Isotope Ration
Magnesium	Chloride	Technicium-99	Carbon Tetrachloride	pH	
Sodium	Bromide	Iodine-129	TCE	Alkalinity	Oxygen Isotope Ratio
Potassium	Fluoride	Strontium-90	PCE	Dissolved Oxygen	
Strontium Antimony Arsenic	Nitrate	Plutonium isotopes (Pu-238, -239- 240, and -241)	Benzene	Specific Conductivity	Strontium Isotope Ratio
Boron Beryllium Cadmium	Nitrite	Uranium isotopes (U-234, -235, and -238)	Toluene		Hydrogen Isotope Ratio
Chromium	Phosphate	Am-241	Carbon Disulfide		
Lead		Np-237	Pyridine		
Silver		Ce-137			
Thallium		Mercury			

a. These analyses are conditional upon reciept of research funding for a separate study. Should the research grant be funded these analyses will be conducted.

4.5.4 Suction Lysimeter Sampling

Suction lysimeters are dedicated sampling equipment that are buried in the subsurface. For this reason they do not require cleaning prior to sampling. Because sample volumes may be limited, field chemistry data are not usually collected.

Sampling of lysimeters will follow the procedure delineated in TPR-EM-GW-97, "Installing Lysimeters and Sampling Soil Pore Water." If sufficient sample volume can be collected, the sample water will be analyzed for the same chemical suite as the perched water (Table 4-4). If only a limited amount of water can be collected, then samples will be prioritized as below.

4.5.5 Groundwater Sample Prioritization.

Due to the potential difficulties of sampling perched water, a sufficient volume of sample may not be available to meet all of the analytical needs. For this reason the available sample volume will be allocated to meet the following analytical requirements in the order listed below:

1. Radionuclides (unfiltered)
2. Cations and anions
3. Metals—Hg (filtered and unfiltered)
4. VOCs.

Table 4-4. Specific sample requirements for perched water samples.

Analytical Parameter	Container Size and Type	Preservation	Holding Time
Metals (Ca, Mg, Na, K, Sr, B, Sb, As, Be, Cd, Cr, Pb, Se, Ag, Ti, and Hg)	1-L glass or polyethylene bottle	HNO_3 to pH <2	180 days Hg has 28 days
Anions (Br, Cl, F, NO_3, NO_2, PO_4, SO_4)	50 ml glass or polyethylene bottle	Cool to 4°C	NO_3, NO_2, PO_4 have 48 hours All others 28 days
Tritium	100 ml glass bottle	None	6 months
Technicium-99	1-L HDPE bottle	HNO_3 to pH <2	6 months
Iodine-129	1-L HDPE bottle	HNO_3 to pH <2	6 months
Strontium-90	1-L HDPE bottle		6 months
Plutonium isotopes (Pu-238, -239, -240, and -241)	1-L HDPE bottle	HNO_3 to pH <2	6 months
Uranium isotopes (U-234, -235, and -238)	1-L HDPE bottle	HNO_3 to pH <2	6 months
Np-237	1-L HDPE bottle	HNO_3 to pH <2	6 months
Am-241	1-L HDPE bottle	HNO_3 to pH <2	6 months
Ce-137	2-L HDPE bottle	None	6 months
Mercury	1-L amber glass bottle	None	6 months
VOCs	2 × 40 ml vials	H_2SO_4 to pH <2, Cool to 4°C	14 days

4.6 Sampling Quality Assurance/Quality Control.

Section 6 of this FSP and the QAPjP require QA/QC samples from the aquifer and perched groundwater sampling. Laboratories approved by the SMO will be used for the analyses of all such samples. QA/QC samples will be collected at the frequency recommended in the QAPjP, but not less than one set per well set.

4.6.1 Groundwater QA/QC Samples.

QA/QC samples are required only for the perched and aquifer wells and piezometers, not the suction lysimeters. Rinsate samples are required for samples collected from wells and piezometers. QA/QC sampling of the suction lysimeters would be difficult because the sample volume is often limited. Should lysimeter sample volume be sufficient to permit collection of duplicate sample, one will be collected. If additional sample volume is available, duplicate samples will be collected at a frequency of 1 per 20 samples or 1 per day, whichever is less.

4.7 Corrective Actions

In the event a discrepancy is discovered by field personnel or auditors, some form of corrective action will be initiated. The level of action taken is related to the level of the discrepancy. Corrective actions can range from field changes due to unforeseen field conditions to DOE reportable incidents. All corrective actions will be addressed following MCP-598, "Deficiency Screening and Resolution," (INEEL 1999c) and MCP-2811, "Design and Engineering Change Control" (INEEL 1999d).